Appendix D – Noise Analysis Report

Highway Noise Analysis Report

Interstate 229 - Exit 4 (Cliff Avenue)

Sioux Falls, SD

South Dakota DOT

SDDOT 147016 | October 22, 2021

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Highway Noise Analysis Report

Interstate 229 - Exit 4 (Cliff Avenue)

Prepared for the South Dakota Department of Transportation (SDDOT) in cooperation with the Federal Highway Administration and the City of Sioux Falls.

1 Project Overview

The purpose of this analysis is to evaluate and document the effect of the proposed interchange improvements at I-229 – Exit 4 at Cliff Avenue on traffic noise levels in the project area. The project area is located in the City of Sioux Falls, South Dakota.

1.1 Project Background and History

The stakeholders for this project include the City of Sioux Falls, the Sioux Falls Metropolitan Planning Organization (MPO), South Dakota Department of Transportation (SDDOT), and the Federal Highway Administration (FHWA). SDDOT, in partnership with the other project stakeholders, is completing an environmental study of the Interstate Highway 229 (I-229) interchange and its approach roadways at Exit 4 (Cliff Avenue) in Sioux Falls, South Dakota. This study will build on the work and findings of recently completed studies for the area, including, the 2010 Decennial Interstate Corridor Study, the I-229 Major Investment Study (MIS), and the I-229 Exit 4 Interchange Modification Justification Report (IMJR).

The Exit 4 interchange, in its current state, was identified as having safety and capacity problems in the 2010 Decennial Interstate Corridor Study, which identified the need for improvements at the interchange. The 2010 study also recommended the widening of I-229 in the study area to add an additional lane in each direction by the forecast year 2020.

The more recent I-229 MIS was completed and included recommendations for interchange improvements at the Exit 4 interchange. The MIS initially evaluated a broad range of alternatives for I-229 and Minnesota Avenue at the Exit 4 location, and ultimately recommended three alternatives to be carried forward for further evaluation. For additional project history and background, see Section 1 of the I-229 and Cliff Avenue Interchange Environmental Assessment. Since the proposed interchange improvements qualify the project as a Type I project, a traffic noise analysis was completed for incorporation into the Environmental Assessment.

1.2 Project Description and Limits

The project includes the reconstruction of the existing I-229 Exit 4 Interchange, from a modified diamond interchange to Single Point Urban Interchange (SPUI), with 41st Street realigned with Pam Road.

The noise modeling limits include the following roadway limits: I-229 to Exit 3 (Minnesota Avenue) to I-229 to Exit 5 ramps (E 26th Street). The City of Sioux Falls' Minnesota Avenue study limits include 38th Street to the north and Park Road to the south.

It should be noted the roadway limits extend further than the project noise areas in order to capture the entire noise environment; the project noise areas are defined in **Section 5** of this report.

1.3 Project Assessment

This study was conducted in accordance with the Noise Analysis and Abatement Guidance for SDDOT (2011) and Federal Highway Administration (FHWA) Noise Regulation found at 23 CFR 772.

The analysis utilized FHWA's Traffic Noise Model 2.5 (TNM 2.5) software model. The analysis includes modeling of existing conditions (2018) and future (2050) build conditions.

2 Noise Overview

Noise is defined as any unwanted sound. Sound travels in a wave motion and produces a sound pressure level. This sound pressure level is commonly measured in decibels. For highway traffic noise, an adjustment, or weighting, of the high- and low-pitched sounds, is made to approximate the way that an average person hears sounds. The adjusted sound levels are stated in units of "A-weighted decibels" (dBA).

A-weighted decibels (dBA) represent the logarithmic increase (decrease) in sound energy relative to a reference energy level. A sound increase of 3 dBA is barely perceptible to the human ear, a 5 dBA increase is clearly noticeable, and a 10 dBA increase is heard as twice as loud. For example, if the sound energy is doubled (e.g., the amount of traffic doubles), there is a three dBA increase in noise, which is just barely noticeable to most people. On the other hand, if the traffic volumes increase by a factor of ten the sound energy level increases by 10 dBA, which is heard as a doubling of the loudness.

The following **Figure 1** provides a rough comparison of the noise levels of some common noise sources.

Figure 1 – Decibel Levels of Common Noise Sources

150	Jet take off (at close range on the ground)
130	Machine gun, riveting machine
120	Thunderclap
117	jet plane (at passenger ramp)
107	Loud power mower
94	Pneumatic jackhammer
90	Sports car, truck, shouted conversation
50-60	Normal conversation
50	Quiet street
40	Quiet room
0	Threshold of Audibility

Source: "City Noise: Designers Can Restore Quiet, at a Price," by Harold W. Bredlin, *Product Engineering*, (November 1968) as cited in "The Audible Landscape: A Manual for Highway Noise and Land Use; Appendix B" (June 2017) Federal Highway Administration, https://www.fhwa.dot.gov

Along with traffic volumes, vehicle speeds, roadway grades, and topography, the distance of a receptor from a sound's source is also a significant factor that contributes to the level of traffic noise. Sound level decreases as the distance from the source increases. A general rule regarding sound level decrease due to increasing distance is: outside of approximately 50 feet, every time the distance between a line source, such as a roadway, and a receptor is doubled, the sound level decreases by either 3 dBA over hard surfaces or 4.5 dBA over soft surfaces.

2.1 Federal Regulations

The Federal Noise Abatement Criteria (23 CFR 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise) established the noise criteria for various land uses. The criteria are in terms of the L_{eq} descriptor. L_{eq} is an equivalent steady-state sound level which contains the same acoustic energy as the time-varying sound level during the same time period.

Federal Noise Abatement Criteria (NAC) apply to all Type I projects requiring FHWA approval, regardless of funding source, or Type I projects requiring Federal-aid highway funds.

This project includes the construction of a new interchange at I-229 and Cliff Avenue. The reconstruction of the interchange, with the addition of lanes qualifies it as a Type I project. For the full definition of Type I projects see the definitions at link:

https://dot.sd.gov/media/documents/FinalNoiseAnalysisandAbatementGuidance071311.pdf

According to 23 CFR 772, a noise impact is defined as occurring when the predicted traffic noise levels:

- Approach or exceed the noise abatement criteria (see **Table 1**)
- Substantially exceed the existing noise levels

Table 1 – FHWA Noise Abatement Criteria

Activity Category	Activity Criteria[1,2] $L_{eq}(h)$ dBA	Evaluation Location	Activity Description
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose
B[3]	67	Exterior	Residential
C[3]	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E[3]	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F
F	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	--	--	Undeveloped lands that are not permitted.

Notes:
(1) $L_{eq}(h)$ shall be used for impact assessment
(2) $L_{eq}(h)$ Activity Criteria values are for impact determination only, and are not design standards for noise abatement
(3) Includes undeveloped lands permitted for this activity category

2.2 State Regulations

South Dakota DOT Noise Analysis and Abatement Guidance for SDDOT (2011) has defined “approach or exceed” as when the predicted L_{eq} is within one dBA, or less, or exceeds the L_{eq} given for the activity category in the NAC (Table 1), and “substantially exceed” as an increase of 15 dBA or more over existing noise levels.

In South Dakota, traffic noise impacts are evaluated by measuring and/or modeling the traffic noise levels that exceed the equivalent steady-state sound level of the time during the worst hour traffic volumes for the design year. This number is identified as the L_{eq} levels; the L_{eq} value is compared to FHWA noise abatement criteria.

3 Methodology

3.1 Affected Environment

The purpose of this noise analysis is to determine the impacts the proposed project has on traffic noise levels in the immediate vicinity of the project at noise sensitive receptors (residences, businesses, parks, etc). It is important to note that this analysis only includes traffic generated noise. There are other noise sources in the project area that have some effect on the ambient noise levels.

The project will reconstruct the existing interchange into a SPUI at I-229 and Cliff Avenue, as well as other roadway improvements associated with the project.

3.2 Field Monitoring

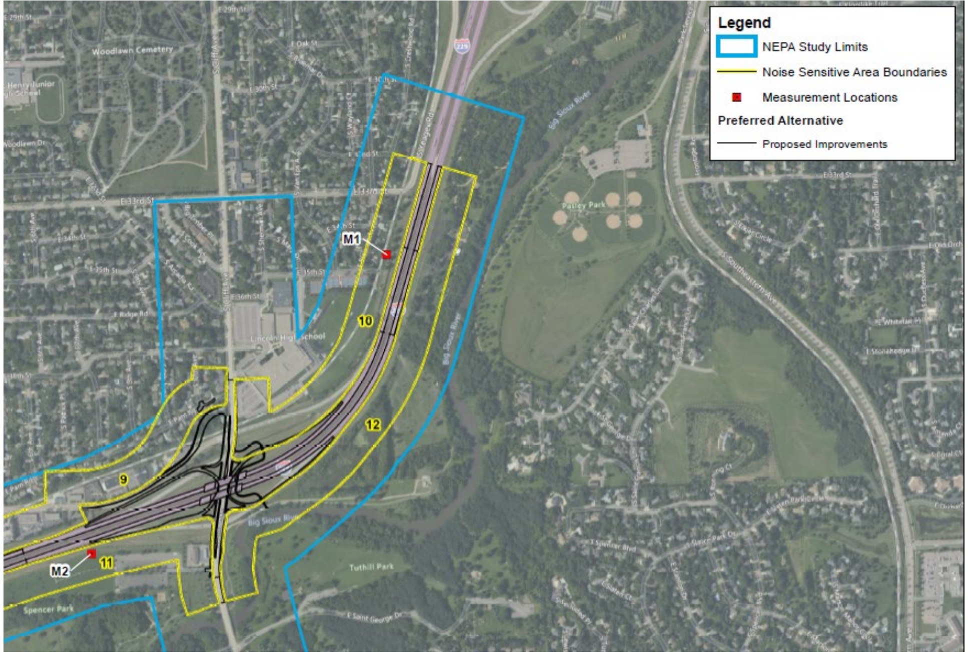
Noise level monitoring is required for noise studies to document existing noise levels and assist in validating the noise prediction model. Monitored noise levels can also be used as a baseline of the possible ambient noise levels that can occur with a new roadway alignment.

The existing noise levels in the I-229 - Cliff Avenue project area were monitored at two sites on December 18th, 2018. The monitoring location sites are illustrated in **Figure 2**, Existing Conditions. The two sites were selected to have field measurements done, to capture existing noise along the study limits; most of the project area where proposed improvements occur are undeveloped or very few sensitive receptors nearby. Site M1 was selected based on the close proximity to existing I-229 southbound traffic within a residential area. Site M2 was selected based on the close proximity to existing I-229 northbound traffic.

Short-term noise measurements of 20 minutes were conducted at each of these locations and were used to validate the model. Concurrent traffic data was collected for the duration of each monitoring session, which was then used to develop hourly volumes for each site for the validation model. The noise level monitoring results are shown on the monitoring summary sheets in **Appendix D** and ranged from 70.1 dBA (L_{eq}) to 72.6 dBA (L_{eq}). The monitoring time periods had good weather (no precipitation with winds less than 12 mph), and dry pavement; the sound level meter utilized was a Larson Davis model 831 that was laboratory calibrated in February of 2018.

Field data sheets were generated for each site, including collected traffic data, weather, wind speed, time and location of measurement, as well as any other observed noise sources that occurred during the measurement. Field data sheets and photographs of each measurement location and can be found in **Appendix D**.

Figure 2 – Existing Conditions – Monitor Locations and Project Area



3.3 Noise Model Validation

To verify the accuracy of the noise model, the modeled noise level results must be within +/- 3 dBA of the monitored noise levels (*Highway Traffic Noise: Analysis and Abatement Guidance*, Federal Highway Administration, Washington, DC, December 2011, pp. 31–32). The monitoring results are provided in **Table 2,** which shows the results of the validation modeling to be within the 3 dBA limits for the L_{eq} for both of the monitored sites. Since the sites were within 3 dBA difference between the measured and modeled results, the model is considered validated.

Table 2 – Noise Monitoring Locations & Results

Site ID	Location/Description	Measurement Date/Time	Measured Levels, dBA	Modeled Levels, dBA	Difference dBA
			L_{eq}	L_{eq}	L_{eq}
M1	Spencer Park (South of I-229 NB)	December 18, 2018 3:34 pm to 3:55 pm	70.1	71.2	1.1
M2	Residential Property (North of I-229 SB, near E 35th St)	December 18, 2018 2:52 pm to 3:14 pm	72.6	73.2	0.6

4 Noise Analysis

4.1 Noise Modeling

Traffic noise impacts were assessed by modeling noise levels at noise sensitive receptor locations likely to be affected by the construction of the proposed project. SDDOT Noise Analysis and Abatement Guidance defines the noise study area for the build alternative to be from the beginning project construction point to the ending project construction point. The minimum distance to look for receptors is 300 feet from the edge of pavement. If an impact is identified at 300 feet, the next closest receptor would need to be analyzed until a distance where impacts are no longer identified is reached. If no receptors are located within the 300-foot zone, then the closest receptor(s) should be analyzed.

The project receptors were divided up into 4 separate Noise Sensitive Areas (NSA) based on proximity of adjacent receptors and roadway access locations, as shown in **Appendix A Figure 1; Noise Analysis Overview Map.** In the existing condition, there were a total of 115 representative receptor locations throughout the project area. The Build condition removes 7 residential receptors through right-of-way acquisitions; therefore, the Build Condition has a total of 108 receptors. The majority of receptors represented residential receptors, consisting mostly of single-family homes. There are several receptors located along the parks, located on the south side of I-229. There are a number of commercial properties in NSA 9; however, none of them were identified as having an exterior area of frequent human use; commercial properties without an exterior use were not included with a receptor location. The locations of the existing and future build modeled receptor sites are illustrated in **Appendix C Figures 1 through 2**; Noise Analysis Future Build and Barrier Results.

The attached **Table 3** includes the receptor site ID and land use for each receptor.

The noise modeling for both the existing noise levels and future build noise levels was done using the noise prediction program TNM 2.5, which was developed for FHWA. The model uses the roadway alignment (horizontal and vertical), traffic volumes, traffic speeds, vehicle classification, and the distances from the roadway center-of-lanes to the receptors as well as relative elevation differences. In general, higher traffic volumes, vehicle speeds, and numbers of heavy trucks increases the loudness of highway traffic noise. For determining the worst-case traffic noise hour, traffic noise levels were modeled for both morning peak hourly volumes and evening peak hourly volumes, to determine which time period resulted in more receptor impacts. The following assumptions were used in modeling the noise levels for this project:

- Traffic data input into the noise model included Existing (year 2018) and Build (year 2050) forecast traffic volumes from the Intersection Justification Report (IJR). Year 2050 was identified as the design year for the proposed project.
- Existing 24-hour vehicle data was used to determine that the morning and evening peak hourly traffic occurs between 7:15 a.m. to 8:15 a.m. and 4:30 p.m. and 5:30 p.m, respectively; however, the morning peak hour from 7:15 a.m. to 8:15 p.m. resulted in more receptor impacts and was considered the "worst traffic noise hour".
- Vehicular fleet composition was determined based on vehicle class counts provided along I-229, near Exit 1 and Exit 9.

4.2 Noise Model Results

Results of the noise modeling analysis are tabulated in the attached **Table 3, Noise Analysis Summary Table**. The following describes the results of the traffic noise analysis for existing (2018) and future (2050) Build condition.

Existing (2018) modeled noise levels at the modeled receptor locations range from 59.2 dBA (L_{eq}) to 73.5 dBA (L_{eq}). Modeled noise receptors exceeded FHWA Noise Criteria (L_{eq}) at 27 of 115 modeled receptor locations under existing (2018) conditions.

Future (2050) Build modeled noise levels at the modeled receptor locations range from 60.3 dBA (L_{eq}) to 75.0 dBA (L_{eq}). Modeled noise receptors exceeded FHWA criteria (L_{eq}) at 54 of 108 modeled receptor locations under Build (2050) conditions, with none of these being from a “substantial increase” in traffic noise due to the proposed project.

Modeled noise level changes range from 0.5 dBA to 2.5 dBA for existing receptor locations when comparing the Build (2050) to the existing (2018) conditions.

Generally, traffic noise levels are increased with the proposed build project due to many factors. A few of the major changes that influence the increases are as follows:

- Traffic demands will significantly increase between the existing (2018) conditions and future (2050) conditions.
- Portions of the proposed roadways will be shifted closer to the existing receptors.

5 Noise Abatement Analysis

Because Federal Noise Abatement Criteria (NAC) are both approached and exceeded at modeled receptor locations for the future (2050) Build conditions throughout the project area, noise abatement must be considered.

Noise mitigation measures have been considered, as listed in 23 CFR 772.13(c) and are addressed below:

- Traffic management measures: The primary purpose of the facility is to move people and goods. Restrictions of certain vehicles or speeds would be inconsistent with the purpose of the project.
- Alteration of horizontal and vertical alignments: The project was aligned for practical reasons based on grade and safety within the available right of way. Redesigning the horizontal and vertical alignments to minimize noise impacts would be impractical for this project.
- Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development that would be adversely impacted by traffic noise: Exclusive land use designations or acquisition of property to serve as a buffer zone between the roadway and adjacent lands would not be feasible because land has already been developed along the project corridor.
- Construction of Noise Barriers: including acquisition of property rights, either within or outside the highway right of way.

Noise barriers have been chosen as the most cost-effective noise mitigation measure available for this project.

The use of quieter pavements is not an acceptable noise abatement measure for Federal-aid projects. Planting of vegetation or landscaping is not an acceptable Federal-aid noise abatement measure because only dense stands of evergreen vegetation at least 100 feet deep will reduce noise levels by a noticeable amount.

5.1 Noise Barrier Evaluation

When noise impacts are identified, a noise barrier evaluation analysis must be performed. Noise barrier construction decisions are determined based on the evaluation of the feasibility and reasonableness of the noise barriers. All of the following conditions must be met in order for noise abatement to be justified and incorporated into the project design. Failure to achieve any single element of feasibility or reasonableness will result in the noise abatement measure being deemed not feasible or not reasonable, as applicable.

Feasibility of the noise barrier is determined by engineering feasibility (i.e., whether a noise barrier could feasibly be constructed on the site) and by acoustic feasibility. Acoustic feasibility is met when a minimum of 60% of front row receptors directly behind the noise wall achieve a 5 dBA noise reduction (the noise wall must extend entirely across receptor's property line). The feasibility of noise barrier construction is sometimes dependent on design details that are not known until the final design of the project. The following analysis assumes that noise barriers could be feasibly constructed throughout the project area, up to 20 feet high along the corridor. Due to safety concerns, SDDOT will generally not construct barriers higher than 20 feet.

Reasonableness is based on three factors determined by the number of benefited receptors from the noise abatement that must be met. A benefited receptor is any receptor behind the noise barrier that receives a minimum noise level reduction of 5 dBA or more. The three reasonableness factors are as follows:

- Based on 2010 construction cost estimates and adjusted for inflation (18.2% cumulative inflation rate 2010-2020, from \$44/ ft^2 and \$21,000), SDDOT will use \$52/ft^2 for barrier costs and \$25,000 as the cost per benefited receptor. If the cost per benefited receptor is more than \$25,000 the abatement measure will not be considered reasonable. The cost calculations for the noise abatement measure should include all items directly related to the construction of the noise abatement measure, including additional costs of some items such as right-of-way, drainage modifications, utility relocation, traffic control, retaining walls, landscaping for graffiti abatement and standard aesthetic treatments.
- At least 40% of benefited receptors must achieve a 7 dBA noise reduction in order for noise abatement to be reasonable. If a barrier is unable to achieve the design goal, further evaluation will not be completed.
- The viewpoints of the property owners and residents of all benefited receptors shall be solicited and considered in reaching a decision on the abatement measure to be provided. See Section 9 of the SDDOT Noise Analysis and Abatement Guidance (effective date: July 13, 2011) for a detailed explanation of the voting system.

5.1.1 Project Summary

Federal Noise Abatement Criteria (NAC) are currently predicted to be both approached and exceeded throughout portions of the study area. Noise barriers were evaluated at 5 barrier locations within the project's 6 noise areas. **Appendix C Build Condition Figures 1-2** illustrates the analysis summary of noise barriers that were considered.

Noise barrier cost-effectiveness results are tabulated in **Appendix B Noise Barrier Tables**.

5.2 Noise Barrier Results

The project receptors were divided up into 4 separate noise sensitive areas based on proximity of adjacent receptors and highway access locations (see **Figure 1** in **Appendix A**).

5.2.1 Noise Area 9 – North of I-229 Southbound (West of Cliff Avenue)

Land use north of I-229 Southbound, west of Cliff Avenue consists of 62 residential receptors, one church with an outdoor playground, and one veterinary clinic with an outdoor area. Noise levels were modeled at 64 receptor locations in the existing condition in Noise Area 9. The Build condition removes 7 residential receptors in this noise area with right-of-way acquisition, for a total of 57 receptor locations. Modeled noise levels approached or exceeded the Federal NAC at 19 of 57 receptor locations with future (2050) Build conditions. A noise barrier was modeled between E 41st Street and I-229 SB On Ramp, in line with the proposed retaining wall at this area, to mitigate traffic noise to receptors 9-7, 9-9, 9-12 to 9-24, 9-70.

Receptors 9-43, 9-57, and 9-58 also exceeded the NAC, however, for a barrier to be modeled along E Pam Road and Cliff Avenue, direct access to the residence could not be maintained. Thus, a noise barrier was not considered feasible for these receptors.

5.2.1.1 Barrier 9-1

An approximately 1,260 foot long, 20-foot high (average) noise barrier was modeled on the north side of I-229 SB On Ramp, west of Cliff Avenue, to mitigate impacts to front row receptors 9-7 and 9-9, as well as receptors 9-12 through 9-24 and 9-70. The noise barrier was unable to achieve a 5 dBA noise reduction for 60% of the front row receptors directly behind the noise barrier and was unable to achieve a noise reduction of 7 dBA or more at minimum of 40% of benefited receptors. Therefore, the barrier is not considered feasible or reasonable and is not proposed.

5.2.2 Noise Area 10 – North of I-229 Southbound (East of Cliff Avenue)

Land use north of I-229 Southbound, east of Cliff Avenue consists of Lincoln High School parcel, which contained 7 receptors at various outdoor sporting areas and 24 residential receptors. Noise levels were modeled at 29 receptor locations in Noise Area 10. Modeled noise levels approached or exceeded the Federal NAC at 17 of 31 receptor locations with future (2050) Build conditions. Two noise barriers were modeled in this noise area. The first noise barrier was modeled across the Lincoln High School parcel, to mitigate traffic noise to these noise sensitive outdoor sporting areas. The second noise barrier was modeled along the north side of I-229 Southbound, to mitigate traffic noise to the residential homes along Blauvelt Avenue.

5.2.2.1 Barrier 10-1

An approximately 2,050 foot long, 8.5-foot high (average) noise barrier was modeled on the north side of I-229 Southbound, east of Cliff Avenue, to mitigate impacts to the outdoor sporting areas at Lincoln High School. The noise barrier was able to achieve a 5 dBA noise reduction at a minimum of 60% of front row receptors and was able to achieve a 7 dBA noise reduction at a minimum of 40% of the benefited receptors. However, the cost cost per benefited receptor is $302,389, which exceeds the allowable CE threshold of $25,000 benefited receptor. Therefore, the barrier is not considered reasonable and is not proposed.

5.2.2.2 Barrier 10-2

An approximately 1,100 foot long, 16.1-foot-high noise barrier was modeled on the north side of I-229 Southbound, east of Cliff Avenue, to mitigate impacts to the residential receptors 10-10 through 10-29, and 10-35. The noise barrier was able to achieve a 5 dBA noise reduction at a minimum of 60% of front row receptors and was able to achieve a 7 dBA noise reduction at a minimum of 40% of the benefited receptors. However, the cost per benefited receptor is $83,460, which exceeds the allowable CE threshold of $25,000 benefited receptor. Therefore, the barrier is not considered reasonable and is not proposed.

5.2.3 Noise Area 11 – South of I-229 Northbound (West of Cliff Avenue)

Land use south of I-229 Northbound, west of Cliff Avenue consists of Spencer Park. The park's parcel containing various sporting fields. There is also one commercial property with an outdoor seating area, along the north side of Park Road, on Cliff Avenue.

Noise levels were modeled at 11 receptor locations in Noise Area 11, which represented seating areas at the sporting fields as well as the commercial property. Modeled noise levels approached or exceeded the Federal NAC at 9 of 11 receptor locations with future (2050) Build conditions.

5.2.3.1 Barrier 11-1

An approximately 2271 foot long, 9.0-foot high (average) noise barrier was modeled on the south side of I-229 Northbound, west of Cliff Avenue, to mitigate impacts to the receptors located at Spencer Park. The noise barrier was able to achieve a 5 dBA noise reduction at a minimum of 60% of front row receptors and was able to achieve a 7 dBA noise reduction at a minimum of 40% of the benefited receptors. However, the cost per benefited receptor is $106,401, which exceeds the allowable CE threshold of $25,000 benefited receptor. Therefore, the barrier is not considered reasonable and is not proposed.

5.2.4 Noise Area 12 – South of I-229 Northbound (East of Cliff Avenue)

Land uses south of I-229 Northbound, east of Cliff Avenue consist of City of Sioux Falls' Tuthill Park and YMCA's Leif Erikson Park. Tuthill Park has receptors for disk golf, sports seating areas, and picnic areas. Leif Erikson Park has various receptors throughout the outdoor recreational area. Noise levels were modeled at 11 receptor locations in Noise Area 12. Modeled noise levels approached or exceeded the Federal NAC at 2 of 11 receptor locations with future (2050) Build conditions.

5.2.4.1 Barrier 12-1

An approximately 2,450 foot long, 12.7-foot high (average) noise barrier was modeled on the south side of I-229 Southbound, east of Cliff Avenue, to mitigate impacts to the recreational area receptors 12-8 and 12-9. The noise barrier was able to achieve a 5 dBA noise reduction at a minimum of 60% of front row receptors and was able to achieve a 7 dBA noise reduction at a minimum of 40% of the benefited receptors. However, the cost per benefited receptor is $230,594, which exceeds the allowable CE threshold of $25,000 benefited receptor. Therefore, the barrier is not considered reasonable and is not proposed.

6 Construction Noise

The construction activities associated with implementation of the proposed project will result in increased noise levels relative to existing conditions. These impacts will primarily be associated with construction equipment and pile driving.

The following table (**Table 4**) shows peak noise levels monitored at 50 feet from various types of construction equipment. This equipment is primarily associated with site grading/site preparation, which is generally the roadway construction phase associated with the greatest noise levels.

Table 4 – Typical Construction Equipment Noise Levels at 50 Feet

Equipment Type	Manufacturers Sampled	Total Number of Models in Sample	Peak Noise Levels (dBA)	
			Range	Average
Backhoes	5	6	74-92	83
Front Loaders	5	30	75-96	85
Dozers	8	41	65-95	85
Graders	3	15	72-92	84
Scrapers	2	27	76-98	87
Pile Drivers	N/A	N/A	95-105	101

Source: United States Environmental Protection Agency and Federal Highway Administration

Elevated noise levels are, to a degree, unavoidable for this type of project. SDDOT will require that contractors comply with the sound control requirements identified in the SDDOT Standard Specifications for Roads and Bridges. Construction noise abatement will be determined by weighing the duration of the project, benefits achieved, overall adverse social, economic and environmental effects, and cost of abatement measures.

It is anticipated that night construction may be required to minimize traffic impacts and to improve safety. However, construction will be limited to daytime hours as much as possible. If necessary, a detailed nighttime construction mitigation plan will be developed during the project final design stage.

Any associated high-impact equipment noise, such as pile driving, pavement sawing, or jack hammering, will be unavoidable with construction of the proposed project. Pile-driving noise is associated with any bridge construction and sheet piling necessary for retaining wall construction. High-impact noise construction activities will be limited in duration to the greatest extent possible. While pile-driving equipment results in the highest peak noise level, as shown in **Table 4**, it is limited in duration to the activities noted above (e.g., bridge construction). The use of pile drivers, jack hammers, and pavement sawing equipment will be prohibited during nighttime hours.

7 Conclusions

Noise levels surrounding the I-229/Cliff Avenue interchange project area exceed Federal NAC criteria for several single-family receptors and recreational receptors under the future build (2050) conditions.

In general, the reconstruction of the I-229 interchange (Exit 4) at Cliff Avenue will result in increases in traffic noise levels compared to the existing conditions. Modeled build (2050) condition noise levels increase from 0.5 dBA to 2.5 dBA over the existing (2018) conditions.

Generally, traffic noise levels are increased with the proposed build project due to many factors. Some of the major changes that influence the increases are as follows:

- Traffic demands will increase between the existing (2018) conditions and future (2050) conditions.
- The I-229 corridor will be widened to three through-lanes, plus the reconstruction of the interchange into a SPUI. The construction of additional lanes along I-229 and widening of Cliff Avenue shifts the traffic closer to the existing receptors, resulting in increased noise levels.

Acoustic reasonableness and cost effectiveness were calculated for each of the 5 noise barriers that were evaluated for this study. None of the noise barriers were found to be both reasonable and feasible and will not be proposed to be incorporated into the project.

If there are any significant changes to the final design of the I-229 and Cliff Avenue Interchange project, the environmental document may need to be re-evaluated.

Tables

Table 3 – Noise Analysis Summary Table

Table 3
Noise Analysis Summary
Existing and Future Scenarios

Noise Level Comparison to Standards	
XX	**Bold**; Approach or Exceeds FHWA Activity Criteria
XX	Underline; substantial increase (15 dBA) in noise levels
N/A	Receptor does not exist in Scenario

Receiver		FHWA Activity (dBA)		Existing Modeled 2018 Conditions		
					Future Build Conditions	Difference - Existing and Build
Receptor ID	Land Use	Activity Category	Criteria L_{eq}	L_{eq}	L_{eq}	L_{eq}
Noise Area 9 - North of I-229 Southbound, West of Cliff Ave						
9-7	General	C	67	**68.2**	**69.8**	1.6
9-9	General	C	67	65.2	**66.7**	1.5
9-12	Residential	B	67	63.9	**66.0**	2.1
9-13	Residential	B	67	64.1	**66.3**	2.2
9-14	Residential	B	67	64.9	**67.0**	2.1
9-15	Residential	B	67	65.2	**67.3**	2.1
9-16	Residential	B	67	64.1	**66.2**	2.1
9-17	Residential	B	67	65.2	**67.0**	1.8
9-18	Residential	B	67	65.3	**67.1**	1.8
9-19	Residential	B	67	65.5	**67.2**	1.7
9-20	Residential	B	67	65.7	**67.4**	1.7
9-21	Residential	B	67	65.6	**67.2**	1.6
9-22	Residential	B	67	65.0	**66.5**	1.5
9-23	Residential	B	67	64.6	**66.1**	1.5
9-24	Residential	B	67	64.6	**66.1**	1.5
9-25	Residential	B	67	64.4	65.9	1.5
9-26	Residential	B	67	64.2	65.7	1.5
9-27	Residential	B	67	64.5	65.8	1.3
9-28	Residential	B	67	64.4	65.6	1.2
9-29	Residential	B	67	64.2	N/A	
9-30	Residential	B	67	64.3	N/A	
9-31	Residential	B	67	64.4	N/A	
9-32	Residential	B	67	64.2	N/A	
9-33	Residential	B	67	64.6	N/A	
9-34	Residential	B	67	65.3	N/A	
9-35	Residential	B	67	**66.9**	N/A	
9-36	Residential	B	67	62.0	63.6	1.6
9-37	Residential	B	67	62.6	64.0	1.4
9-38	Residential	B	67	62.5	63.9	1.4
9-39	Residential	B	67	63.4	64.7	1.3
9-40	Residential	B	67	62.4	63.7	1.3
9-41	Residential	B	67	62.3	63.8	1.5
9-42	Residential	B	67	63.2	65.2	2.0
9-43	Residential	B	67	64.8	**67.3**	2.5
9-44	Residential	B	67	62.1	63.5	1.4
9-45	Residential	B	67	62.4	63.8	1.4
9-46	Residential	B	67	62.5	63.8	1.3
9-48	Residential	B	67	62.3	63.8	1.5
9-49	Residential	B	67	63.3	65.3	2.0
9-50	Residential	B	67	63.3	65.2	1.9
9-51	Residential	B	67	62.0	63.4	1.4
9-52	Residential	B	67	62.0	63.5	1.5

Table 3
Noise Analysis Summary
Existing and Future Scenarios

Noise Level Comparison to Standards	
XX	**Bold**; Approach or Exceeds FHWA Activity Criteria
XX	Underline; substantial increase (15 dBA) in noise levels
N/A	Receptor does not exist in Scenario

Receiver		FHWA Activity (dBA)		Existing Modeled 2018 Conditions	Future Build Conditions	Difference - Existing and Build
Receptor ID	Land Use	Activity Category	Criteria L_{eq}	L_{eq}	L_{eq}	L_{eq}
Noise Area 9 - North of I-229 Southbound, West of Cliff Ave						
9-53	Residential	B	67	61.9	63.4	1.5
9-54	Residential	B	67	63.0	65.0	2.0
9-55	Residential	B	67	61.7	63.3	1.6
9-56	Residential	B	67	63.1	65.0	1.9
9-57	Residential	B	67	63.9	**66.3**	2.4
9-58	Residential	B	67	65.6	**68.1**	2.5
9-59	Residential	B	67	63.6	65.6	2.0
9-60	Residential	B	67	61.1	63.3	2.2
9-61	Residential	B	67	61.0	63.2	2.2
9-62	Residential	B	67	61.0	63.2	2.2
9-63	Residential	B	67	61.6	63.8	2.2
9-64	Residential	B	67	62.5	64.5	2.0
9-65	Residential	B	67	63.2	65.0	1.8
9-66	Residential	B	67	62.9	64.8	1.9
9-67	Residential	B	67	62.7	64.5	1.8
9-68	Residential	B	67	62.2	63.8	1.6
9-69	Residential	B	67	63.8	65.9	2.1
9-70	Residential	B	67	63.9	**66.0**	2.1
9-71	Residential	B	67	63.7	65.7	2.0
9-72	Residential	B	67	64.0	65.9	1.9
9-73	Residential	B	67	63.8	65.7	1.9
9-74	Residential	B	67	63.9	65.8	1.9
Noise Area 10 - North of I-229 Southbound, East of Cliff Ave						
10-1	General	C	67	**70.8**	**72.3**	1.5
10-2	General	C	67	**72.7**	**74.6**	1.9
10-4	General	C	67	61.9	63.5	1.6
10-6	General	C	67	**72.7**	**74.7**	2.0
10-7	General	C	67	**66.6**	**68.7**	2.1
10-8	General	C	67	63.8	65.8	2.0
10-9	General	C	67	61.9	63.6	1.7
10-10	Residential	B	67	**70.8**	**72.6**	1.8
10-11	Residential	B	67	**70.8**	**72.7**	1.9
10-12	Residential	B	67	**70.6**	**72.5**	1.9
10-13	Residential	B	67	**70.5**	**72.5**	2.0
10-14	Residential	B	67	**70.7**	**72.7**	2.0
10-15	Residential	B	67	**70.9**	**72.8**	1.9
10-16	Residential	B	67	**69.6**	**71.6**	2.0
10-17	Residential	B	67	**70.4**	**72.4**	2.0
10-18	Residential	B	67	**68.1**	**70.0**	1.9
10-19	Residential	B	67	**70.9**	**72.8**	1.9
10-20	Residential	B	67	**71.4**	**73.2**	1.8

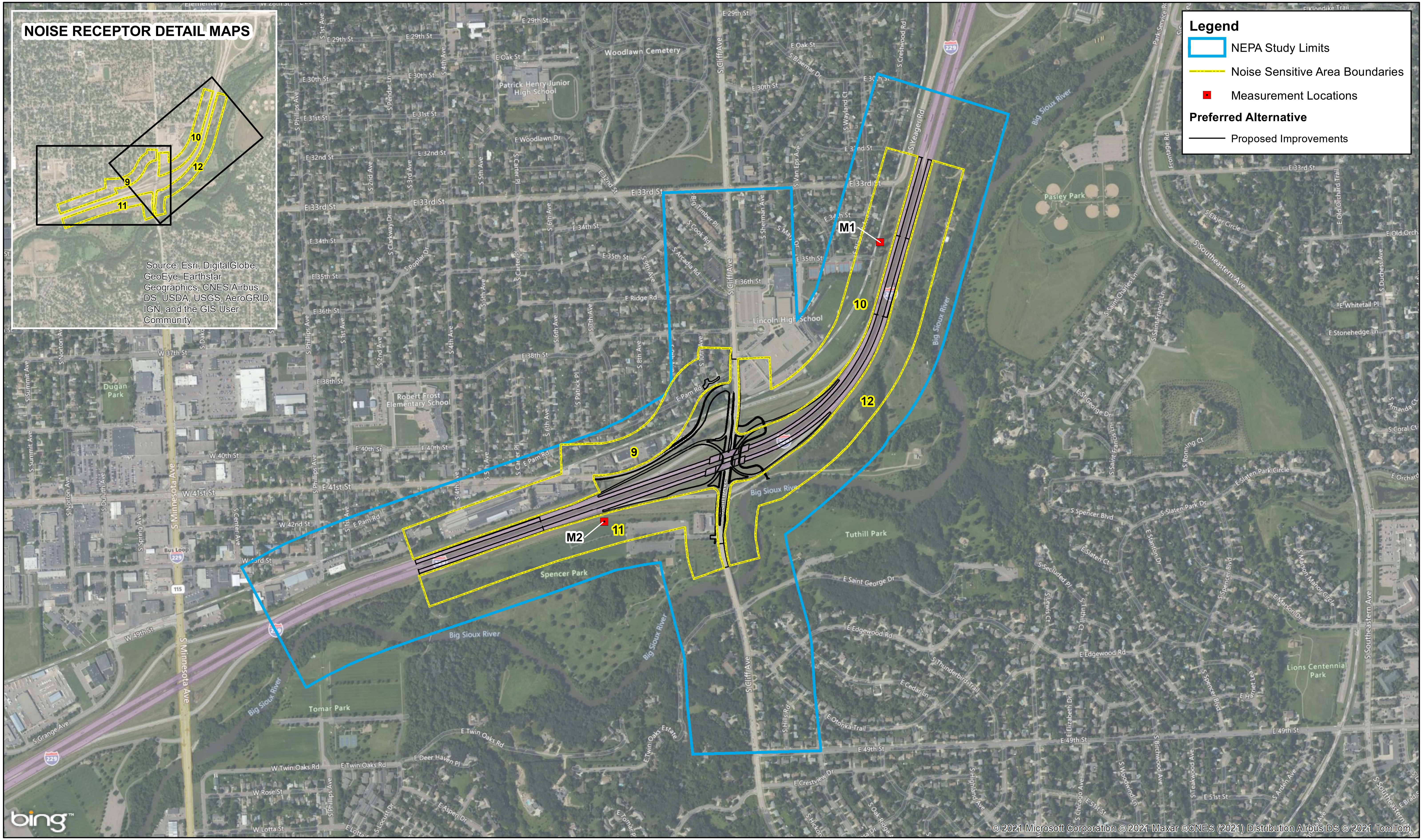
Table 3
Noise Analysis Summary
Existing and Future Scenarios

Noise Level Comparison to Standards	
XX	**Bold**; Approach or Exceeds FHWA Activity Criteria
XX	Underline; substantial increase (15 dBA) in noise levels
N/A	Receptor does not exist in Scenario

Receiver		FHWA Activity (dBA)		Existing Modeled 2018 Conditions	Future Build Conditions	Difference - Existing and Build
Receptor ID	Land Use	Activity Category	Criteria L_{eq}	L_{eq}	L_{eq}	L_{eq}
Noise Area 10 - North of I-229 Southbound, East of Cliff Ave						
10-21	Residential	B	67	**67.1**	**69.0**	1.9
10-22	Residential	B	67	**68.2**	**70.0**	1.8
10-23	Residential	B	67	65.5	**67.3**	1.8
10-24	Residential	B	67	65.5	**67.2**	1.7
10-25	Residential	B	67	65.5	**67.7**	2.2
10-26	Residential	B	67	64.2	**66.2**	2.0
10-27	Residential	B	67	65.2	**67.3**	2.1
10-28	Residential	B	67	64.9	**67.0**	2.1
10-29	Residential	B	67	64.0	**66.0**	2.0
10-30	Residential	B	67	63.6	65.5	1.9
10-31	Residential	B	67	62.2	64.0	1.8
10-35	Residential	B	67	65.2	**67.0**	1.8
10-36	Residential	B	67	63.8	65.5	1.7
Noise Area 11 - South of I-229 Northbound, West of Cliff Ave						
11-1	Park/Sports Area	C	67	**73.5**	**75.0**	1.5
11-2	Park/Sports Area	C	67	**73.2**	**74.7**	1.5
11-3	Park/Sports Area	C	67	**71.8**	**73.4**	1.6
11-4	Park/Sports Area	C	67	**69.3**	**71.0**	1.7
11-5	Park/Sports Area	C	67	**68.3**	**69.8**	1.5
11-6	Park/Sports Area	C	67	**68.0**	**69.4**	1.4
11-7	Park/Sports Area	C	67	**66.6**	**68.3**	1.7
11-8	Park/Sports Area	C	67	**67.0**	**68.5**	1.5
11-9	Park/Sports Area	C	67	**66.3**	**67.8**	1.5
11-10	Commercial	E	72	67.2	67.6	0.4
11-11	Park/Sports Area	C	67	64.2	65.9	1.7
Noise Area 12 - South of I-229 Northbound, East of Cliff Ave						
12-3	Recreation Area	C	67	64.3	64.6	0.3
12-4	Recreation Area	C	67	61.5	61.7	0.2
12-5	Recreation Area	C	67	61.6	61.5	-0.1
12-6	Recreation Area	C	67	59.2	60.3	1.1
12-7	Recreation Area	C	67	65.2	65.7	0.5
12-8	Recreation Area	C	67	64.9	**66.4**	1.5
12-9	Recreation Area	C	67	64.5	**66.2**	1.7
12-10	Recreation Area	C	67	64.0	65.7	1.7
12-11	Recreation Area	C	67	65.0	64.9	-0.1
12-12	Recreation Area	C	67	64.0	64.5	0.5
12-13	Recreation Area	C	67	63.4	64.4	1.0

Appendix A

Noise Analysis Overview Map (1)



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401 East 8th Street
Suite 309
Sioux Falls, SD 57103
(605) 330-7000

Print Date: 9/16/2021
Source: Bing Maps, Lincoln County

Map by: mfalk
Projection: State Plane
South Dakota S

Noise Analysis Overview Map

Exit 4 (Cliff Avenue) Interchange
Minnehaha County, SD

Appendix B

Noise Barrier Tables

Table B1
Build Noise Barrier Cost Effectiveness (Noise Area 9)
Barrier 9-1

				Future Noise Levels		Acoustic Effectiveness			Cost Effectiveness ($52/SF)					
Noise Barrier	Receiver	Land Use	FHWA Noise Standard (Leq dBA)	Build (Leq dBA)	Build with Barriers (Leq dBA)	dBA Reduction	Number of Receptors	[2]Front Row Benefited Receptors (-5 dBA)	Barrier Length (ft)	Average Barrier Height (ft)	Area of Barrier (SF)	Total Cost	Cost per Benefited Receptor	Feasible/ Reasonable
9-1	9-7	C	67	69.8	63.0	-6.8	1	1	1260	20	24021	$1,249,092	$178,442	NO
	9-9	C	67	66.7	62.6	-4.1	1	0						
	9-12	B	67	66.0	62.4	-3.6	1	-						
	9-13	B	67	66.3	62.1	-4.2	1	-						
	9-14	B	67	67.0	62.2	-4.8	1	-						
	9-15	B	67	67.3	62.1	-5.2	1	-						
	9-16	B	67	66.2	61.5	-4.7	1	-						
	9-17	B	67	67.0	61.5	-5.5	1	-						
	9-18	B	67	67.1	61.5	-5.6	1	-						
	9-19	B	67	67.2	61.7	-5.5	1	-						
	9-20	B	67	67.4	62.0	-5.4	1	-						
	9-21	B	67	67.2	62.2	-5.0	1	-						
	9-22	B	67	66.5	62.0	-4.5	1	-						
	9-23	B	67	66.1	62.0	-4.1	1	-						
	9-24	B	67	66.1	62.4	-3.7	1	-						
	9-25	B	67	65.9	62.9	-3.0	1	-						
	9-26	B	67	65.7	63.3	-2.4	1	-						
	9-36	B	67	63.6	61.8	-1.8	1	-						
	9-62	B	67	63.2	59.9	-3.3	1	-						
	9-63	B	67	63.8	60.3	-3.5	1	-						
	9-64	B	67	64.5	60.8	-3.7	1	-						
	9-65	B	67	65.0	61.6	-3.4	1	-						
	9-66	B	67	64.8	61.5	-3.3	1	-						
	9-67	B	67	64.5	61.4	-3.1	1	-						
	9-68	B	67	63.8	61.8	-2.0	1	-						
	9-69	B	67	65.9	62.6	-3.3	1	-						
	9-70	B	67	66.0	63.1	-2.9	1	-						

Number of Benefited Receptors (Front Row) = 1 (50%) Goal of 60% or greater

[1]Total Number of Benefited Receptors = 7

Number of Benefited Receptors meeting Design Goal (7 dBA Reduction) = 0 (0%) Goal of 40% or greater

[1]All receptors with a noise reduction of at least 5 dBA from the barrier

[2]Non-front row receptors denoted with a dash

Table B2

Build Noise Barrier Cost Effectiveness (Noise Area 10)

Barrier 10-1

Noise Barrier	Receiver	Land Use	FHWA Noise Standard (Leq dBA)	Future Noise Levels		Acoustic Effectiveness			Cost Effectiveness ($52/SF)					Feasible/ Reasonable
				Build (Leq dBA)	Build with Barriers (Leq dBA)	dBA Reduction	Number of Receptors	[2]Front Row Benefited Receptors (-5 dBA)	Barrier Length (ft)	Average Barrier Height (ft)	Area of Barrier (SF)	Total Cost	Cost per Benefited Receptor	
10-1	10-1	C	67	72.3	65.2	-7.1	1	1	2050	8.5	17446	$907,166	$302,389	NO
	10-2	C	67	74.6	67.6	-7.0	1	1						
	10-4	C	67	63.5	62.2	-1.3	1	-						
	10-6	C	67	74.7	69.7	-5.0	1	1						
	10-7	C	67	68.7	66.4	-2.3	1	-						
	10-8	C	67	65.8	64.3	-1.5	1	-						
	10-9	C	67	63.6	62.8	-0.8	1	-						

Number of Benefited Receptors (Front Row) = 3 (100%) Goal of 60% or greater

[1]Total Number of Benefited Receptors = 3

Number of Benefited Receptors meeting Design Goal (7 dBA Reduction) = 2 (67%) Goal of 40% or greater

[1] All receptors with a noise reduction of at least 5 dBA from the barrier

[2] Non-front row receptors denoted with a dash

Table B3
Build Noise Barrier Cost Effectiveness (Noise Area 10)
Barrier 10-2

Noise Barrier	Receiver	Land Use	FHWA Noise Standard (Leq dBA)	Future Noise Levels		Acoustic Effectiveness			Cost Effectiveness ($52/SF)					Feasible/ Reasonable
				Build (Leq dBA)	Build with Barriers (Leq dBA)	dBA Reduction	Number of Receptors	[2]Front Row Benefited Receptors (-5 dBA)	Barrier Length (ft)	Average Barrier Height (ft)	Area of Barrier (SF)	Total Cost	Cost per Benefited Receptor	
10-2	10-10	B	67	72.6	67.6	-5.0	1	1	1100	16.1	17655	$918,060	$83,460	NO
	10-11	B	67	72.7	65.6	-7.1	1	1						
	10-12	B	67	72.5	65.6	-6.9	1	1						
	10-13	B	67	72.5	65.3	-7.2	1	1						
	10-14	B	67	72.7	65.3	-7.4	1	1						
	10-15	B	67	72.8	64.7	-8.1	1	1						
	10-16	B	67	71.6	65.4	-6.2	1	1						
	10-17	B	67	72.4	64.0	-8.4	1	1						
	10-18	B	67	70.0	64.9	-5.1	1	1						
	10-19	B	67	72.8	66.6	-6.2	1	1						
	10-20	B	67	73.2	67.7	-5.5	1	1						
	10-21	B	67	69.0	64.4	-4.6	1	-						
	10-22	B	67	70.0	65.7	-4.3	1	-						
	10-23	B	67	67.3	64.2	-3.1	1	-						
	10-24	B	67	67.2	64.6	-2.6	1	-						
	10-25	B	67	67.7	65.7	-2.0	1	-						
	10-26	B	67	66.2	64.7	-1.5	1	-						
	10-27	B	67	67.3	65.0	-2.3	1	-						
	10-28	B	67	67.0	64.6	-2.4	1	-						
	10-29	B	67	66.0	63.8	-2.2	1	-						
	10-30	B	67	65.5	63.8	-1.7	1	-						
	10-31	B	67	64.0	63.0	-1.0	1	-						
	10-35	B	67	67.0	64.7	-2.3	1	-						
	10-36	B	67	65.5	64.0	-1.5	1	-						

Number of Benefited Receptors (Front Row) =	11	(100%)	Goal of 60% or greater
[1]Total Number of Benefited Receptors =	11		
Number of Benefited Receptors meeting Design Goal (7 dBA Reduction) =	5	(45%)	Goal of 40% or greater

[1] All receptors with a noise reduction of at least 5 dBA from the barrier

[2] Non-front row receptors denoted with a dash

Table B4
Build Noise Barrier Cost Effectiveness (Noise Area 11)
Barrier 11-1

Noise Barrier	Receiver	Land Use	FHWA Noise Standard (Leq dBA)	Future Noise Levels		Acoustic Effectiveness			Cost Effectiveness ($52/SF)					Feasible/ Reasonable
				Build (Leq dBA)	Build with Barriers (Leq dBA)	dBA Reduction	Number of Receptors	[2]Front Row Benefited Receptors (-5 dBA)	Barrier Length (ft)	Average Barrier Height (ft)	Area of Barrier (SF)	Total Cost	Cost per Benefited Receptor	
11-1	11-1	C	67	75.0	66.1	-8.9	1	1	2271	9.0	20462	$1,064,009	$106,401	NO
	11-2	C	67	74.7	63.9	-10.8	1	1						
	11-3	C	67	73.4	65.1	-8.3	1	1						
	11-4	C	67	71.0	64.1	-6.9	1	-						
	11-5	C	67	69.8	62.3	-7.5	1	-						
	11-6	C	67	69.4	62.4	-7.0	1	-						
	11-7	C	67	68.3	63.3	-5.0	1	-						
	11-8	C	67	68.5	62.2	-6.3	1	-						
	11-9	C	67	67.8	61.5	-6.3	1	-						
	11-11	C	67	65.9	60.9	-5.0	1	-						

Number of Benefited Receptors (Front Row) = 3 (100%) Goal of 60% or greater

[1]Total Number of Benefited Receptors = 10

Number of Benefited Receptors meeting Design Goal (7 dBA Reduction) = 5 (50%) Goal of 40% or greater

[1] All receptors with a noise reduction of at least 5 dBA from the barrier

[2] Non-front row receptors denoted with a dash

Table B5
Build Noise Barrier Cost Effectiveness (Noise Area 12)
Barrier 12-1

				Future Noise Levels		Acoustic Effectiveness			Cost Effectiveness ($52/SF)					
Noise Barrier	Receiver	Land Use	FHWA Noise Standard (Leq dBA)	Build (Leq dBA)	Build with Barriers (Leq dBA)	dBA Reduction	Number of Receptors	[2]Front Row Benefited Receptors (-5 dBA)	Barrier Length (ft)	Average Barrier Height (ft)	Area of Barrier (SF)	Total Cost	Cost per Benefited Receptor	Feasible/ Reasonable
12-1	12-7	C	67	65.7	60.1	-5.6	1	1	2450	12.7	31042	$1,614,158	$230,594	NO
	12-8	C	67	66.4	59.4	-7.0	1	1						
	12-9	C	67	66.2	58.8	-7.4	1	1						
	12-10	C	67	65.7	58.6	-7.1	1	1						
	12-11	C	67	64.9	58.9	-6.0	1	1						
	12-12	C	67	64.5	58.8	-5.7	1	1						
	12-13	C	67	64.4	59.4	-5.0	1	1						

Number of Benefited Receptors (Front Row) = 7 (100%) Goal of 60% or greater

[1]Total Number of Benefited Receptors = 7

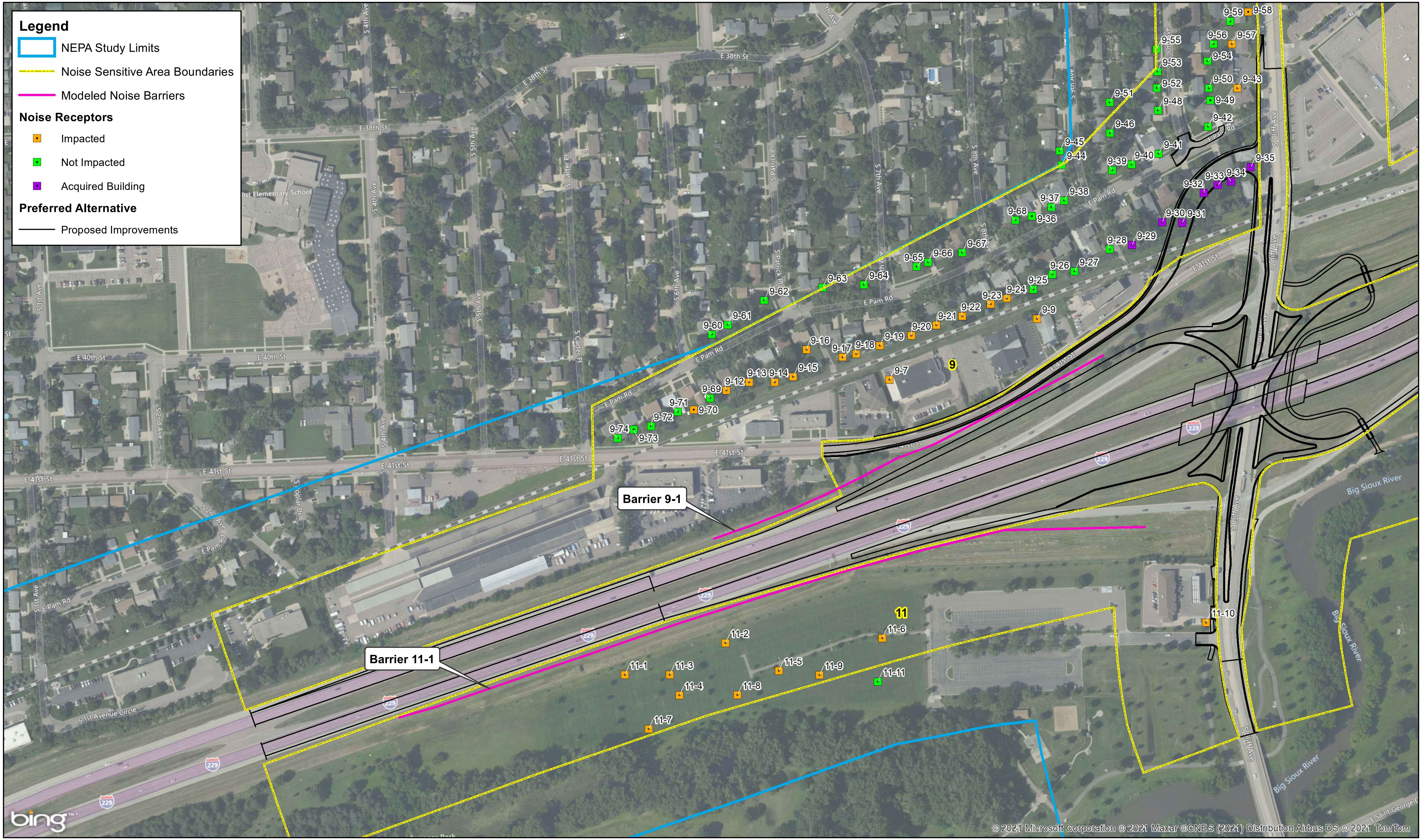
Number of Benefited Receptors meeting Design Goal (7 dBA Reduction) = 3 (43%) Goal of 40% or greater

[1] All receptors with a noise reduction of at least 5 dBA from the barrier

[2] Non-front row receptors denoted with a dash

Appendix C

Future Build and Barrier Results Figure (1-2)



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Suite 309
Sioux Falls, SD 57103
(605) 330-7000

Print Date: 10/22/2021
Source: Bing Maps, Lincoln County

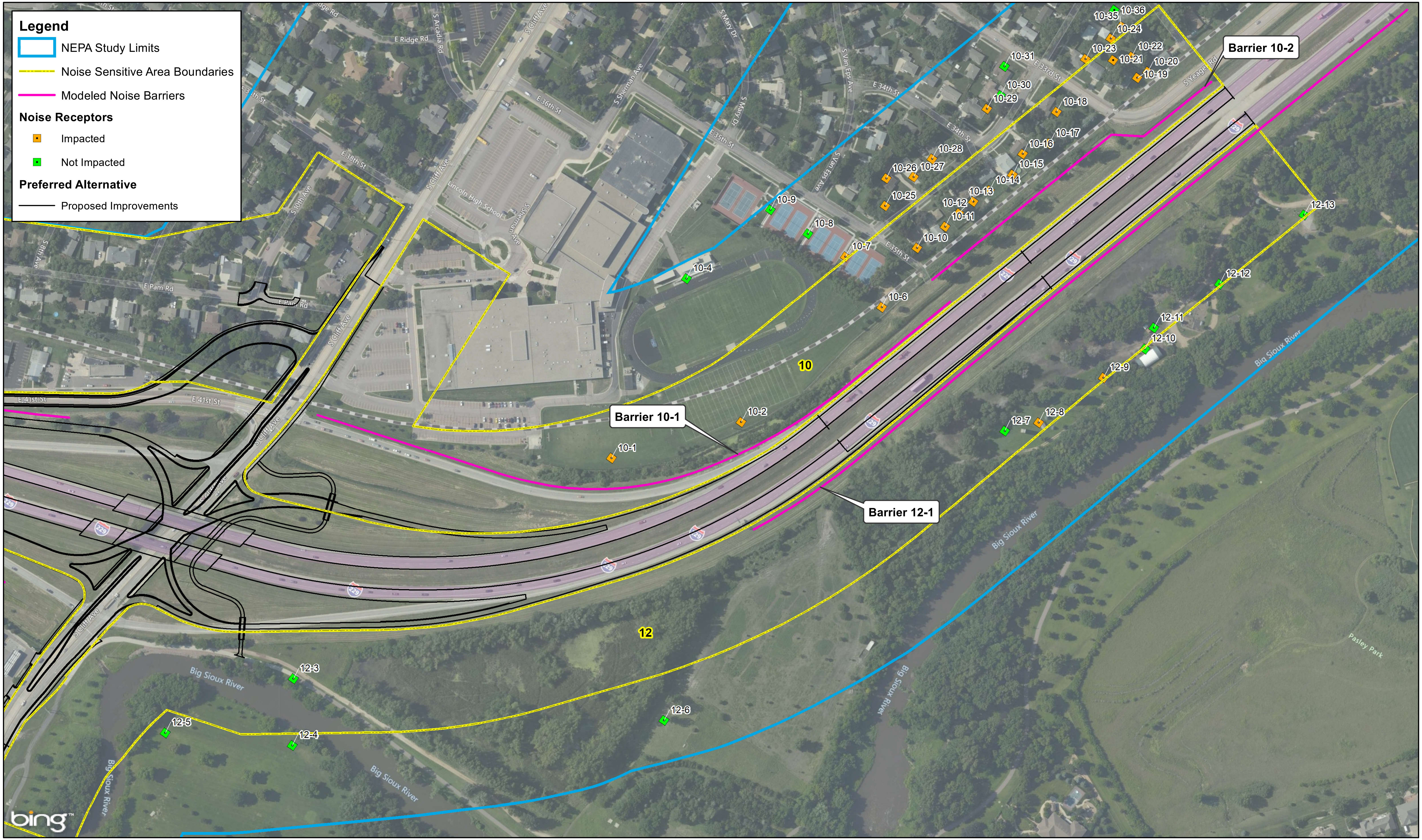
Map by: mfalk
Projection: State Plane South Dakota S

Future Build and Barrier Results Figure - NSA's 9 and 11

Exit 4 (Cliff Avenue) Interchange

Minnehaha County, SD

Feet
0 250 500



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401 East 8th Street
Suite 309
Sioux Falls, SD 57103
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Print Date: 10/22/2021
Source: Bing Maps, Lincoln County

Map by: mfalk
Projection: State Plane South Dakota S

Future Build and Barrier Results Figure - NSA's 10 and 12

Exit 4 (Cliff Avenue) Interchange

Minnehaha County, SD

Appendix D

Noise Monitoring Data

Summary

File Name	831_Data.061
Serial Number	0004132
Model	Model 831
Firmware Version	2.314
User	Graham Johnson
Location	Sioux Falls, SD
Job Description	I-229 Exits 3 & 4
Note	

Monitor Location M1:
Residential Property (North of I-229 SB, near E 35th St)
Coords: 43.52062 N, 96.70593 W
Traffic (Cars/MT/HT estimated hourly from short count):
NB - 1218 / 423 / 36
SB - 1428 / 174 / 66

Measurement Description

Start	2018-12-18 14:52:27
Stop	2018-12-18 15:15:01
Duration	00:22:34.6
Run Time	00:21:59.2
Pause	00:00:35.4
Pre Calibration	2018-12-18 14:41:17
Post Calibration	None
Calibration Deviation	---

Overall Settings

RMS Weight	A Weighting		
Peak Weight	A Weighting		
Detector	Fast		
Preamp	PRM831		
Microphone Correction	Off		
Integration Method	Linear		
Gain	0.0 dB		
Overload	144.3 dB		
	A	**C**	**Z**
Under Range Peak	**76.9**	73.9	78.9 dB
Under Range Limit	**26.6**	27.0	32.9 dB
Noise Floor	17.4	17.9	23.3 dB

Results

LAeq	70.1 dB	
LAE	101.3 dB	
EA	1.503 mPa²h	
LApeak (max)	2018-12-18 14:56:13	90.9 dB
LAFmax	2018-12-18 15:03:49	79.2 dB
LAFmin	2018-12-18 15:11:24	60.9 dB
SEA	-99.9 dB	

LAF > 65.0 dB (Exceedance Counts / Duration)	11	1286.6 s
LAF > 85.0 dB (Exceedance Counts / Duration)	0	0.0 s
LApeak > 135.0 dB (Exceedance Counts / Duration)	0	0.0 s
LApeak > 137.0 dB (Exceedance Counts / Duration)	0	0.0 s
LApeak > 140.0 dB (Exceedance Counts / Duration)	0	0.0 s

Community Noise	**Ldn**	**LDay 07:00-23:00**	**LNight 23:00-07:00**	**Lden**	**LDay 07:00-19:00**	**LEvening 19:00-23:00**
	70.1	70.1	-99.9	70.1	70.1	-99.9

LCeq	75.1 dB
LAeq	70.1 dB
LCeq - LAeq	5.0 dB
LAIeq	70.9 dB
LAeq	70.1 dB
LAIeq - LAeq	0.8 dB
# Overloads	0
Overload Duration	0.0 s

Statistics

LAF5.00	73.3 dB
LAF10.00	72.4 dB
LAF33.30	70.6 dB
LAF50.00	69.5 dB
LAF66.60	68.3 dB
LAF90.00	66.3 dB

Calibration History

Preamp	**Date**	**dB re. 1V/Pa**	**6.3**	**8.0**	**10.0**
PRM831	2018-12-18 14:41:14	-26.9	79.4	66.7	69.6
PRM831	2018-11-29 16:32:07	-26.9	57.1	64.2	58.9
PRM831	2018-11-27 14:50:27	-26.8	61.0	64.9	52.8
PRM831	2018-08-08 11:30:10	-26.8	59.1	62.3	73.2
PRM831	2018-08-08 11:29:18	-26.8	64.5	59.1	64.4
PRM831	2018-06-18 14:38:18	-26.9	63.8	57.0	57.1
PRM831	2018-06-18 14:35:13	-26.9	64.1	67.4	59.7
PRM831	2018-06-18 14:28:37	-26.9	50.1	60.6	64.6
PRM831	2018-06-14 09:37:59	-27.0	50.9	65.4	65.2
PRM831	2018-06-14 09:22:09	-26.9	62.2	67.2	66.8
PRM831	2018-06-04 10:39:14	-26.9	63.8	72.5	58.7

I-229 / Exits 3&4 (noise monitoring)

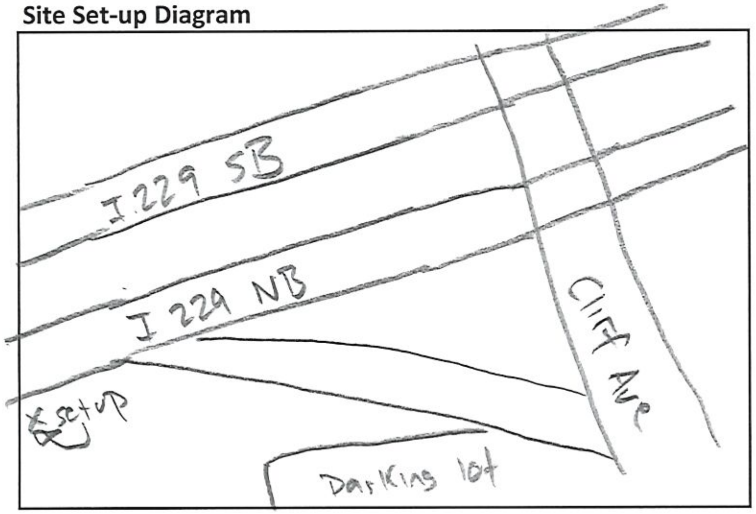
Date: 12/18/18
Location: Spencer Dog Park near I-229 + Cliff Ave
GPS Coordinates: 43.31374, -96.71608
Start time: 15:34
Finish time: 15:55

Photos Taken: [✓ Yes]/No
Calibration of Unit: [✓ Yes]/No

Wind 3 mph from SE

Vehicle Count	I 229 South-Bound Traffic	**Total**
25 25 **passenger car**	卌 |	476
single-unit truck	卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 |||	58
bus	||||	4
semi truck / heavy truck	卌 卌 卌 卌 ||	22
Total		

Site Set-up Diagram



Noise Comments

Person walking his dog along trail in dog park in first 3-4 minutes of recording.

I-229 / Exits 3&4 (noise monitoring)

Date: 12/18/18
Location: Spencer Dog Park
GPS Coordinates: 43.51374, -96.71608
Start time: 15:34
Finish time: 15:55

Photos Taken: [✓ Yes]/No
Calibration of Unit: [✓ Yes]/No

Wind speed 3 mph from S.E.

Vehicle Count	North Bound I-229	**Total**
passenger car		406
single-unit truck		141
bus		13
semi truck / heavy truck		12
Total		

Site Set-up Diagram

See southbound Drawing

Noise Comments

See SB.

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Site M1: Northeast of I-229 SB, near 35th Street. Camera facing east (12/28/2018)

Summary

File Name	831_Data.062
Serial Number	0004132
Model	Model 831
Firmware Version	2.314
User	Graham Johnson
Location	Sioux Falls, SD
Job Description	I-229 Exits 3 & 4
Note	

Monitor Location M2:
Spencer Park (South of I-229 NB)
Coords: 43.51374 N, 96.71608 W
Traffic (Cars/MT/HT estimated hourly from short count):
NB - 1077 / 243 / 66
SB - 999 / 282 / 45

Measurement Description

Start	2018-12-18 15:34:13
Stop	2018-12-18 15:55:21
Duration	00:21:07.8
Run Time	00:21:05.2
Pause	00:00:02.6
Pre Calibration	2018-12-18 15:30:13
Post Calibration	None
Calibration Deviation	---

Overall Settings

RMS Weight	A Weighting
Peak Weight	A Weighting
Detector	Fast
Preamp	PRM831
Microphone Correction	Off
Integration Method	Linear
Gain	0.0 dB
Overload	144.3 dB

	A	**C**	**Z**
Under Range Peak	**76.9**	73.9	78.9 dB
Under Range Limit	**26.6**	27.0	32.9 dB
Noise Floor	17.5	17.9	23.3 dB

Results

LAeq	72.6 dB	
LAE	103.6 dB	
EA	2.552 mPa²h	
LApeak (max)	2018-12-18 15:54:47	96.4 dB
LAFmax	2018-12-18 15:54:47	87.8 dB
LAFmin	2018-12-18 15:37:26	63.5 dB
SEA	-99.9 dB	

LAF > 65.0 dB (Exceedance Counts / Duration)	1	1265.0 s
LAF > 85.0 dB (Exceedance Counts / Duration)	1	1.5 s
LApeak > 135.0 dB (Exceedance Counts / Duration)	0	0.0 s
LApeak > 137.0 dB (Exceedance Counts / Duration)	0	0.0 s
LApeak > 140.0 dB (Exceedance Counts / Duration)	0	0.0 s

Community Noise	**Ldn**	**LDay 07:00-23:00**	**LNight 23:00-07:00**	**Lden**	**LDay 07:00-19:00**	**LEvening 19:00-23:00**
	72.6	72.6	-99.9	72.6	72.6	-99.9

LCeq	77.3 dB
LAeq	72.6 dB
LCeq - LAeq	4.7 dB
LAIeq	73.4 dB
LAeq	72.6 dB
LAIeq - LAeq	0.8 dB
# Overloads	0
Overload Duration	0.0 s

Statistics

LAF5.00	76.1 dB
LAF10.00	74.9 dB
LAF33.30	72.6 dB
LAF50.00	71.7 dB
LAF66.60	70.7 dB
LAF90.00	68.9 dB

Calibration History

Preamp	**Date**	**dB re. 1V/Pa**	**6.3**	**8.0**	**10.0**
PRM831	2018-12-18 15:30:09	-26.9	65.5	62.1	58.1
PRM831	2018-12-18 14:41:14	-26.9	79.4	66.7	69.6
PRM831	2018-11-29 16:32:07	-26.9	57.1	64.2	58.9
PRM831	2018-11-27 14:50:27	-26.8	61.0	64.9	52.8
PRM831	2018-08-08 11:30:10	-26.8	59.1	62.3	73.2
PRM831	2018-08-08 11:29:18	-26.8	64.5	59.1	64.4
PRM831	2018-06-18 14:38:18	-26.9	63.8	57.0	57.1
PRM831	2018-06-18 14:35:13	-26.9	64.1	67.4	59.7
PRM831	2018-06-18 14:28:37	-26.9	50.1	60.6	64.6
PRM831	2018-06-14 09:37:59	-27.0	50.9	65.4	65.2
PRM831	2018-06-14 09:22:09	-26.9	62.2	67.2	66.8

I-229 / Exits 3&4 (noise monitoring)

Date: 12/18/18
Location: E 35th St. + I-229 near Lincoln High School
GPS Coordinates: 43.52062, -96.70593
Start time: 14:52
Finish time: 15:14

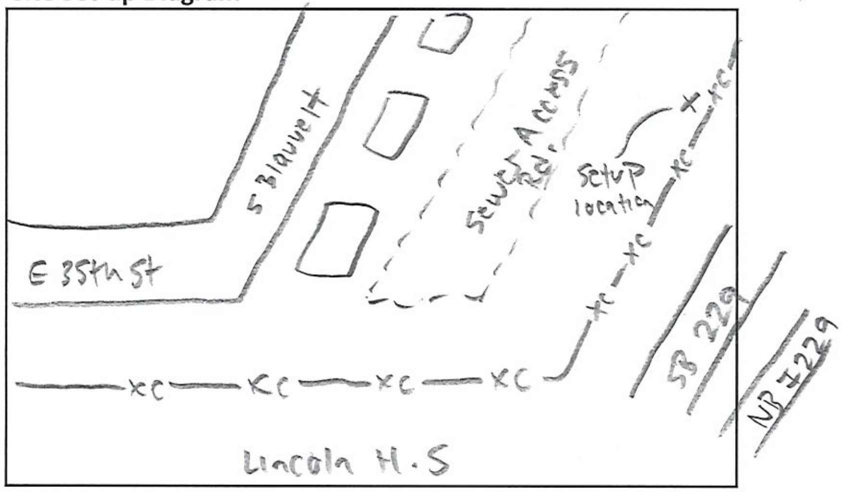
Photos Taken: [✓ Yes]/No
Calibration of Unit: [✓ Yes]/No

Wind 2.4 mph from S.E.

Vehicle Count I-229 South Bound

		Total
passenger car	卌 III	333
single-unit truck	卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 IIII	94
bus	卌	5
semi truck / heavy truck	卌 卌 卌	15
Total		

Site Set-up Diagram



Noise Comments

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I-229 / Exits 3&4 (noise monitoring)

Date: 12/18/2018
Location: E 35th Street & I-229 - near Lincoln H.S.
GPS Coordinates: 43.52062 , -96.70593
Start time: 14:52
Finish time: 15:14

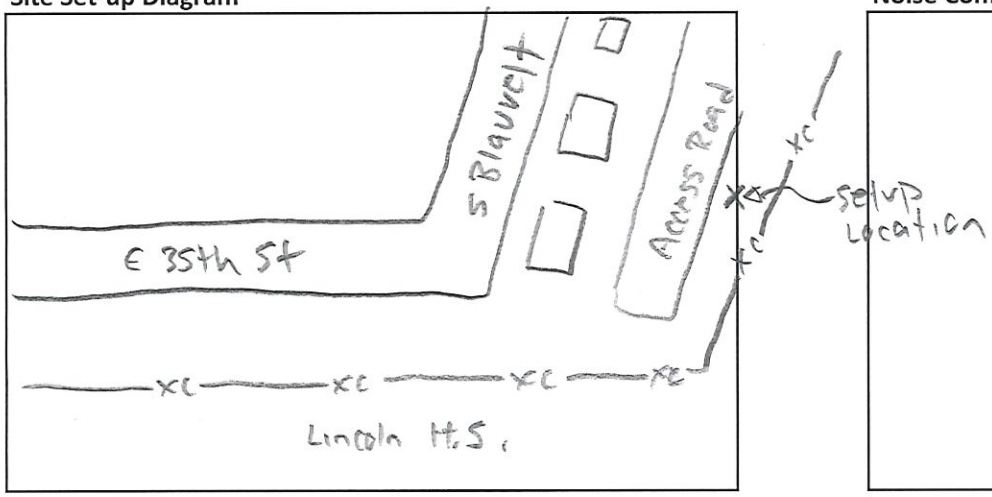
Photos Taken: [✓ Yes]/No
Calibration of Unit: [✓ Yes]/No

Wind 2.4 mph from S.E.

Vehicle Count I-229 NB

		Total
passenger car	𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸 𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸 𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸 𝍸𝍸𝍸𝍸𝍸 ||||	359
single-unit truck	𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸 |	81
bus	|	1
semi truck / heavy truck	𝍸𝍸𝍸𝍸 ||	22
Total		

Site Set-up Diagram



Noise Comments

Site M2: South of I-229 NB, near Spencer Park. Camera facing north (12/28/2018)

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